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XXI.—THE SKIN SPOT DISEASE OF POTATO TUBERS.

(*Oospora pustulans.*)

(With Plate.)

M. Nest Owen.

The disease known as Skin Spot is one of the minor diseases of potato tubers, and one which has never been thoroughly investigated. It is essentially a disease which develops in storage, a fact which probably accounts for its having been so long overlooked and so little understood. In certain seasons, however, Skin Spot is very abundant, and it appears to be becoming more prevalent than formerly. The affected tubers are dotted over with small dark spots, which are at times so numerous as to weaken or even to kill the eyes, and by disfigurement, to lower the market value of the tubers.

In the following paper a description of the causal fungus, which proves to be a new species of the genus *Oospora*, is given, together with an account of its growth in pure culture, infection experiments, and notes as to the effects of the disease on the tubers Although there is room for further work to be carried out with regard to the Skin Spot disease and the causes contributing to its development, it is thought that the results obtained should be placed on record, especially since no detailed account of the disease exists, and the identity of the fungus causing the disease was quite unknown.

Historical.

Carruthers seems to have been the first botanist clearly to distinguish Skin Spot. In March, 1904, he received some potatoes from Lincolnshire, which he states were covered with numerous bluish black warts (Journ. Roy. Agric. Soc. of England, Vol. 65, 1904, pp. 261-262, fig. 2 A-E). When thinly peeled a dark brown patch was found below each wart, and when crowded together the patches became confluent. On dissecting these patches, the cells of the potato were found to be permeated

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with a very fine mycelium. The fungus had consumed the cell-contents, and thickened cell walls formed a corky layer, which separated the diseased part from the healthy cells. He was unable to obtain any fructifications or other characters to determine the fungus present. He gives diagrammatic figures of the external and internal characters of the "wart." In his report for 1909, Carruthers again mentions the recurrence of this particular form of scab, but makes no further comment. Though the description is not very precise these records have usually been regarded as referring to Skin Spot, and a note by Güssow, published last year, proved this assumption to be correct (*see* below).

In 1915, Pethybridge, in his Annual Report on Investigation on Potato Diseases for 1914, gives (p. 35), a note on the occurrence of the disease in Ireland, and proposes the name "Skin Spot." He states it was characterised by the presence on the skin of the tubers of rounded depressed areas, about 2 mm. in diameter, dark brown in colour, with a somewhat lighter coloured, rather well-marked margin, the central portion of each of these shallow pits being usually somewhat raised. He obtained a strong growth of a fungus by exposing cut surfaces of spot to a moist atmosphere. The fungus was identified for him at Kew as *Spicaria solani*. It is possible this species was present, but if so it was probably secondary. No cultural or infection experiments were made. His remarks were illustrated by photographs showing very typical diseased tubers.

Milburn and Bessey in their work "Fungoid Diseases of Farm and Garden Crops," 1915, describe under the heading "Blotches or pimples" (pp. 90-91), a spot on potato tubers evidently identical with the present disease. They refer to Carruthers' paper, and give *Spicaria nivea* as the causal organism. They remark that the spots, though visible at lifting time, are more noticeable after storing, and point out that not only do they render the tubers unsightly and thus reduce the market value, but they may destroy the eyes. They further refer to a case of "Evergood" producing a very irregular crop through the eyes being killed. As far as can be seen from their illustrations, the fungus observed was identical with that described in the present paper. Dr. Milburn informs me that the development of the spot during winter was particularly noticeable on the warp soils of Lincolnshire.

Güssow, in a brief note, describes Skin Spot as occuring in Canada, on potatoes from Quebec (Phytopathology, 8 No. 9, pp. 493, Sept. 1918). He illustrates his remarks with an excellent photograph and states that it is identical with that which he saw in England when working with Carruthers (in 1904). Although he admits the presence of fungal hyphae in the diseased areas, he attributes the disease to bad ventilation during storage, and considers that it occurs most frequently in those cellars where the potatoes are covered with soil to guard against the effects of frost.

In the first Annual Report of the Plant Disease Survey, undertaken by the Food Production Department of the Board of

Agriculture (1917), Skin Spot is listed as a disease prevalent during the winter of 1916-17, especially in the variety "Arran Chief" (Bd. Agric. Miscel. Publ. No. 21, 1918, p. 13). Finally it has been briefly referred to by Mr. A. D. Cotton, in his paper on Potato Diseases issued in the March Supplement of the Board of Agriculture's Journal for March, 1919. It is there stated (p. 47) that the causal fungus is not *Spicaria solani*, but probably an undescribed species.

External Appearance of the Disease.

The external characters of "Skin Spot," although not very striking, are quite distinctive, and there is not much likelihood of confusing it with other "spots." When a large number of potatoes are examined it becomes apparent that the spot may assume a somewhat different form according to the variety of potato on which it occurs. In the case of the coarser-skinned varieties, such as "Arran Chief," a definite pimple is developed, and the skin, whch is never ruptured, is stretched tightly over the swelling, giving it a rather shiny appearance, which is most marked when a number of spots have arisen so close to one another that they coalesce. These swellings when dry are very similar in colour to the normal skin, but on being wetted stand out as a darker brown. In the case of the thinner-skinned and smooth varieties, however, such as "King Edward," the diseased areas are rarely if ever raised, but consist of small sunken dark circular spots with a slightly raised centre, the area being brown or even black in colour. The latter agrees exactly with the description given by Pethybridge. These two forms have never been noted on one and the same tuber; intermediates, however, sometimes occur. In the case of both the pimple and the flat form, each affected area appears to be the result of individual and separate infection, and rarely extends for more than 1 mm. in diameter, or to a greater depth than 2 mm. It has been stated that the rose-end of the tuber is more liable to infection than the heel-end, but when a large number of specimens are examined this statement is not found to hold good. Very frequently, however, one side will be much more spotted than the other. Often the spots occur so close to one another that many of them merge, and thus extend over a considerable area, rendering the tuber very unsightly and injuring a considerable portion of the surface tissue.

A noteworthy point in connection with Skin Spot is the ease with which an entire spot or scab may be picked out. If removed with the point of a needle a white socket of sound potato tissue is usually left behind. The explanation of this is seen by means of a section, when it becomes apparent that the injured area is cuticularised and thus sharply isolated from the cellulose parenchyma of the flesh.

Microscopic Characters.

On sectioning one of these spots the hyphal threads of the invading fungus are plainly seen among the cells of the potato tissue which have become brown and dead. The filaments are

exceedingly fine, 2-4 μ in diameter, hyaline or pale brown. The cell-walls appear to be somewhat thickened and cuticularised and to be lined with a brown substance, due probably to the decomposition of the cell-contents. The fungus penetrates below the periderm and invades the parenchyma, often to a depth of 12-15 cells. The starch grains in the invaded cells entirely disappear. The progress of the fungus is apparently retarded by the cuticularisation of the cell walls, but attempts are also sometimes made on the part of the potato to form definite layers of cork below the affected part (see Fig. 1). In some cases successive

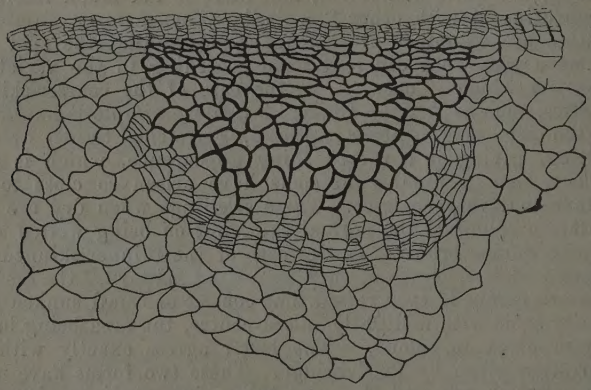


Fig. 1.

layers of cork are formed. Early in April, when the fungus appears to be most vigorous, the hyphae in the diseased cells are very numerous and for the most part hyaline; but later in the season, if similar areas are examined, very few hyphae are found, and these are mostly brown, probably as the result of age. Judging from the smallness of the area which results from each infection, and from the fact that after a certain period of time the hyphae, instead of penetrating to fresh cells, gradually die, the fungus can be regarded as only a very weak parasite on the potato tuber.

Pure Cultures of the Fungus.

No difficulty has been experienced in isolating the fungus in pure culture. The tubers were washed in running water and then placed for ten minutes in ·002 per cent. mercuric chloride solution and afterwards washed in sterile water. In order to lessen still further any chance of contamination the tubers were sometimes dipped in spirit and allowed to dry. The top of a scab was then sliced off with a clean sharp knife and the brown tissue below lifted with a sterile needle and placed on suitable media. In this way a large number of inoculations have been made from different tubers on various media, and in every case a similar

fungus obtained. Care was taken only to use those spots which close examination showed had the skin unbroken.

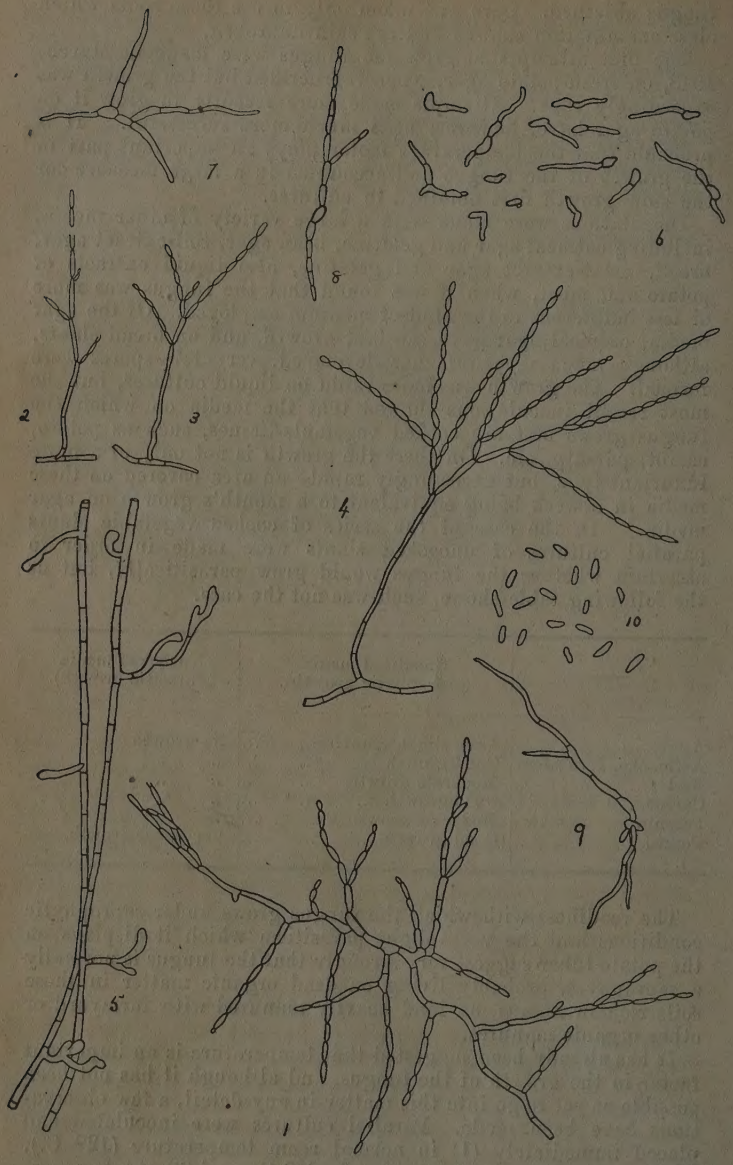
The first attempts to grow the fungus were made in March, 1918, on fresh potato agar, when it fructified but the growth was exceedingly slow. Attempts made more recently to grow it on potato agar have, however, been much more successful. It is probable that the temperature factor plays an important part in the growth of the fungus and accounted in a large measure for the slow growth first obtained in cultures.

Inoculations were made with a large variety of other media, including oatmeal agar and gelatine, bean agar, soil-extract agar, bread, meat-extract agar and gelatine, also liquid extracts of potato and meat, when it was found that the fungus was more or less indifferent to the kind of medium employed. Of the agar media, oatmeal agar gave the best growth, and on bread slants, although much mycelium has developed, very few spores were formed. The growth was more rapid on liquid cultures, but the most recent inoculations showed that the media on which the fungus grows best are cooked vegetable-tissues, such as potato, carrot, parsnip, etc. On these the growth is not only of a more luxuriant type, but exceedingly rapid—an area covered on these media in a week being equivalent to a month's growth on agar media. In the case of the series of cooked vegetable slants parallel cultures of uncooked slants were made in order to ascertain whether the fungus would grow parasitically, but as the following table shows, such was not the case.

—	Sterilised media (saprophytic growth).	Uncooked media (Parasitic growth).
Apple	Very slight growth	No growth.
Artichoke, Jerusalem	Good growth	„ „
Beet	Moderate growth	„ „
Carrot...	Good growth	„ „
Parsnip	Moderate growth	„ „
Potato	Good growth	Very poor growth.

The readiness with which the fungus grows under saprophytic conditions and the very slight parasitism which it displays on the potato tuber suggest very strongly that the fungus is normally a saprophyte, probably living on dead organic matter in those soils rich in humus, on land heavily manured with farmyard or other organic manures.

It has already been suggested that temperature is an important factor in the growth of the fungus, and although it has not been possible as yet to go into this matter in any detail, a few observations have been made. Parallel cultures were inoculated and placed immediately (1) in normal room temperature (12° C.), (2) in an incubator at approximately 24° C., and (3) at a temperature just below freezing point. At the end of a week there was no growth in any of the tubes except in that kept at room temperature. The tube kept at 24° C. and also that kept below



1. The fungus growing in hanging drop culture; after five days, showing young stage, before the development of erect conidiophores. × 250.

2-3. A day or two later, early stages in the development of erect conidiophores. × 250.

4. An erect branched conidiophore. × 250.

5. Appressoria-like organs. Magnification slightly more than 250.

6-7. Spores germinating in hanging drop.

8. Spore germinating by budding.

9. Spore germinating, showing four germ tubes.

10. A group of spores from cooked-vegetable culture, showing slight irregularity of size and shape.

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freezing point were then placed at room temperature. Within a few days that kept below freezing point developed in normal manner, but in the tube kept at 24° C. the spores did not germinate for some considerable time. Light does not seem to be an important factor. The fungus grows more rapidly in complete darkness than in diffuse light, but even in bright light it makes good growth.

Hanging-Drop Cultures.—Owing to the extreme readiness with which the spores become detached, it was found very difficult to observe the exact structure and development of the conidiophores, except by hanging drop cultures. For this purpose a thin film of potato agar was used. Germination takes place in one or other of the following ways a few hours after sowing. Fresh spores may be budded off or a mycelium may be produced, which grows out indefinitely or terminates in a chain of spores. Two or more lateral germ tubes are usually produced near one end, either base or apex, of the spore, which is narrow and elliptical in shape. The first few cells formed are often shorter and more swollen than those of the normal hyphae. The latter are slender and uniform in diameter, 2-4 μ, closely septate, at first hyaline but afterwards pale brown. Towards the edge of the colony peculiar abortive branches are to be noted which may, perhaps, function as appressoria (see Fig. 5, p. 294). Anastomosis takes place, but sparingly. The first formed conidiophores are usually decumbent but the majority are erect (as seen in tube cultures) though never attaining a height of more than 260 μ. The spores are produced at the ends of short hyphae by means of acropetal budding. These spores arise either terminally or laterally with the result that the branching of the conidiophores is quite irregular.

Systematic Position of the Fungus.

From what has been said it is clear that the fungus isolated is a Hyphomycete, belonging to the section *Mucedineae*, and that, judging from the description given by Rabenhorst (Krypt. Flora, Band 1, Abt. 8, p. 352) it is not closely related to *Spicaria solani* as had been suggested. In order to make certain of this point Mr. Cotton kindly wrote to Dr. H. M. Quanjer, of the Wageningen Phytopathological Institute for further details as to this fungus. I am much indebted to Dr. Quanjer for a copy of

the original description, and a copy of the figures by Harting. As the description is difficult to obtain in this country, it appears worth while to transcribe it here in full:—

"1. La surface de plusieurs tubercules appartenant à la variété dite 'Westenbergers' était couverte d'un certain nombre de verrucosités blanches, dont la base se trouvait dans le parenchyme sous l'épiderme. La fig. 1, Pl. III. donne la section d'une telle verrucosité à un grossissement peu fort. J'ai trouvé un champignon appartenant à la même espèce sur la section d'une pomme de terre venue de Munich: la ses filaments ne formaient pas des verrucosités, mais étaient réunis en flocens d'une certaine étendue. Au reste tous les signes caractéristiques étaient absolument les mêmes: la forme générale ne dépend que du lieu où le développement se manifeste.

Les filaments sporifères naissent perpendiculairement des filaments entrelacés qui constituent le mycelium (V. la fig. 2 et 3, Pl. III). Les deux espèces de filaments ont des dissepements. Ceux qui portent les sporules se divisent au sommet en 2-6, ordinairement en 4 ramules, qui ont une forme subulée et dont la direction n'a dévié pas de celle du filament. Les sporules, trés petites, ellipsiodes, naissent au sommet de ces ramules. Quelquefois les filaments se divisent en deux branches, dont chacune se subdivise en ramules sporifères. L'ensemble de tous ces filaments, qui constituent le bord de la verrucosité (fig.1), rappelle un champ couvert d'épis de blé.

Le diamètre des filaments fructifères est de 3, 6-5, 7 mm. La longueur des sporules est de 3, 1-6 mm. Leur largeur de 1, 7-4 mm.

Une description de ce champignon appartenant ainsi que tous les suivants a la famille des Hyphomycetes ne m'est pas connue. Il approche du genre Verticillium Nees, par la manière dont les sporules se forment, mais c'est un Verticillium sans branches latérales, et j'ai donc cru devoir en former un genre nouveau, auquel j'ai donné le nom de Spicaria.

Ses caracteres sont:

Flocci tubulosi septati biformes, steriles decumbentes, fertiles erecti vulgo simplices, apicibus in ramulos fertiles verticillatos divisis; sporidia simplicia, apicibus ramulorum innata iisdemque veluti pedicellata.

Spicaria solani. Floccis albis, decumbentibus dense intertextis, ramulis fertilibus vulgo quatuor erectis, sporidiis minimis ovalibus."

It is clear from the above and especially from the figures kindly supplied by Dr. Quanjer, that the genus *Spicaria*, as founded by Harting, on *S. solani*, does not correspond with the generally accepted views of the genus, which, according to Saccardo (Sylloge Fungorum iv. p. 167), are rightly interpreted by Harz (Bull. Imp. Natur., Moscow. xliv. 1, p. 167. 1871). *S. solani*, as described by Harting, would appear to belong not to the Mucedineae, as commonly supposed, but to Tuberculariеae. The figures suggest that *S. solani* is closely related to the genus *Tubercularia*, if indeed it should not be referred to it.

As the fungus isolated from the Skin Spot bears spores in

chains, which are formed acropetally, it must be placed in the section *Oosporeae*, and Miss E. M. Wakefield, who examined my cultures and material suggests that it would be most suitably placed in the genus *Oospora* itself, and that it must be regarded as an undescribed species. I am much indebted to her for assistance with regard to its systematic position, and for the following description:—

Oospora pustulans, *Owen & Wakef.* sp. nov.

Fungus filamentosus, sub epidermide pustulas minutas nigras efficiens. *Mycelium* repens, delicatulum; hyphae septatae primo hyalinae, 2-4 μ diametro, demum (in cultis) fuscae, torulosae, ad 5-7 (-10) μ diametro. *Conidiophora* erecta, curta, a mycelio haud distincta. *Conidia* cylindrica vel oblonga, hyalina, 6-12 × 2-2·5 μ, aetate provecta intus vacuolata, ideoque spurie 1- septata, in catenas longas plus minusve ramosas digesta.

Habitat: parasitic on tubers of *Solanum tuberosum*, forming minute pustules on the surface.

It should be noted that though the spore chains are sometimes branched, the branching is quite indefinite and the conidia arise directly from the hyphae without the intervention of a special swollen basal cell, as occurs in the section Aspergilleae. In very vigorous cultures the chain of spores are sometimes repeatedly branched and spread out in a fan-like manner.

The discovery of a fungus belonging to the genus *Oospora* at once recalls Thaxter's well-known *Oospora scabies*, the name long given to the organism causing common potato scab. A detailed account of this organism has been given by Lutman and Cunningham (Vermont Agric. Expt. Station. Bull. 184, 1914), where Thaxter's original description is quoted. It will at once be seen that the present organism differs in the possession of much larger hyphae and in the oblong spores borne in chains. Thaxter's plant is in fact not an *Oospora*, and is now generally regarded as belonging to the genus *Actinomyces*.

Inoculation Experiments.

All experiments dealing with the relation of *Oospora pustulans* to its host are much handicapped by the slow development of the fungus. The results of inoculations made under field-conditions in the early summer were not obtained till the following winter or early spring, and it will be necessary to wait another season before the results can be confirmed or amplified.

Two laboratory experiments made with freshly dug tubers of an early variety during June, 1918, may first be described. In order to accelerate the development of the spots, tubers inoculated with spores and placed on damp blotting paper in a large petri dish were kept in an incubator at 22° C. Under these conditions, however, the tubers did not remain normal. The lenticel tissues grew out, and straggly shoots developed from the eyes. At the end of three months there was no obvious sign of infection and the tubers were placed in a dark cellar, being examined periodically, with no results until early in April, when one or two isolated spots were found. In the light of the previous tests,

the general failure of this experiment was probably partly due to the high temperature of the incubator. The other set of experiments in the laboratory was made at ordinary room temperature. A few tubers inoculated in a similar way to the last and at the same time, were placed in a dark cupboard immediately after inoculation. On examining again after some weeks, one of the tubers was observed to be covered with a low-growing white mould. The mould proved to be *Oospora pustulans*. Later examination of the same tubers showed that the white growth had disappeared and its only effect on the tuber was a large brown patch on the skin. The discoloration did not penetrate through the skin to the flesh, and there were no signs of the development of the normal "Skin Spot." This experiment indicates that under very damp and warm conditions the fungus might possibly spread in the clamp without necessarily infecting the tubers, and that certain obscure markings on the skin of potato tubers might be due to injuries caused by *Oospora pustulans*.

Experiments were also carried out on living plants during the growing season, June-August. Inoculations were made on young tubers of potato plants growing in the experimental ground at Kew. In the first set "Midlothian Early" was selected, and the inoculations were made at the beginning of June. The soil was drawn away from the plants until a number of young tubers of different sizes were exposed, and the tubers were sprayed with a concentrated solution of spores of *Oospora pustulans* in sterile water. The soil was then replaced and the plants marked, and a similar number of other plants selected as controls. On lifting the plants in late summer no sign of Skin Spot was present, and examination during the winter gave a similar result. It may be noted that there are as yet no records of early varieties being attacked by this disease, though this may be partly accounted for by their earlier consumption.

The remaining cases inoculated were the late varieties "Provost," "The Ally," and "Secundus." The inoculations were made at the end of July, but that date appeared to be somewhat early, as few tubers had developed. About 4-8 young tubers were inoculated on about 6-8 plants of each variety, and a similar number of uninoculated plants were regarded as controls. The weather at that time was hot and dry and on the first few evenings after inoculation the plants were watered. The dry weather, however, continued for some time and it may perhaps account for the small amount of infection that resulted. At the time of lifting no trace of Skin Spot in any of the three varieties was evident. Much blight was present, and a large number of the tubers had to be discarded. The remainder were stored in a cellar and examined at intervals. No very definite spots developed during the winter. Early in April a few positive results were obtained in the case of both "The Ally" and "Provost." The number of tubers that developed the typical Skin Spot was in each case small, and the infection slight except in the case of one tuber of the "Provost." In this case the spots were crowded together into a circular area as is often the case in normal infection. To confirm the identity of the parasite,

cultures from this tuber were taken in the usual way, and a growth of typical *Oospora pustulans* was obtained. No definite results were obtained from "Secundus," nor were any of the controls affected. It should be noted that had it not been for the large number of tubers destroyed by blight an additional number of successful inoculations would probably have been obtained. One other set of experiments was conducted. Tubers of "Witch Hill" (an early variety) were, after lifting in late September, sprayed with spore solution and placed in the cellar in damp soil. Similarly treated, but unsprayed tubers, were kept as controls. At the end of three months the tubers were examined, but neither then nor later in April, was there any development of Skin Spot. It is desirable to repeat this experiment another season as it is most important to ascertain whether potato tubers may become infected after having been lifted and clamped.

Data which are being collected point to the greater susceptibility of some varieties than others (among which may be mentioned "King Edward," "Arran Chief," and "British Queen") and it is possible that the varieties used for inoculation purposes were more resistant than many others.

Possible Methods of Spread.

The following two sets of experiments were conducted in order to ascertain by what means the disease is carried from one season to another, and its method of spread in the soil.

The first set was carried out in pots. Clean tubers of "Midlothian Early," "Witch Hill," "British Queen," and "May Queen" were planted singly, at the end of April, in soil with which had been mixed peelings of diseased tubers. It was ascertained a few weeks later that the fungus was growing out from the inner side of the potato peelings, and was developing an abundant supply of spores. On examination in the autumn the tubers appeared clean, and in the following spring no spots were manifest, except on one small tuber of "May Queen."

The second series was conducted on the experimental ground at Kew, in a plot where the soil is a sticky silt. In order to test the possibility of the plants contaminating the soil a number of very badly infected tubers were planted in spring. The results showed that very little spread appears to take place during the first season, as on lifting in autumn, the crop was perfectly clean and no spots developed during winter. It should be noted, however, that though the blotches or pimples produced by this fungus are sometimes ruptured under artificial conditions, this does not take place naturally, so that in nature the fungus does not perhaps readily gain access to the soil, probably not until after the tubers decay. Should the soil be suitable for the fungus, in all probability tubers planted the following season would yield an infected crop.

Economic Importance of the Disease.

Since Skin Spot is a disease which develops in store and is not usually visible until the early spring, its economic importance might be expected to be slight. With regard to ware potatoes this is correct, for as its name implies, the diseased areas are for

the most part confined to the skin, and though the flesh of the tuber is penetrated to a slight extent by the fungus, it entails no appreciable waste in peeling. Beyond, therefore, rendering the tubers unsightly, and thus somewhat reducing their market value, this form of injury is not great.

In the case of seed potatoes, however, Skin Spot is of considerably more importance. When a crop in spring shows much infection, or the spots on the tubers are closely crowded together, there is a great danger of the eyes being injured. If the eyes are unaffected the shoots will grow and the plants will yield a normal healthy crop. This has been proved during two consecutive seasons at Kew. It should be remembered, however, that if the soil be suitable for the fungus it may become infected and future potato crops will be liable to suffer. On the other hand, where infection has taken place in the neighbourhood of the eyes, the eyes are definitely injured and even killed. This form of injury was stated to take place by Milburn, though no details as to the nature of the injury are given. It was also noted by Mr. F. T. Brooks and Miss A. D. Mackenzie, and also by Miss K. Sampson. Examination of tubers affected at the eyes shows that the fungus appears to penetrate, particularly deeply, the tissues around the eyes, and that in many cases relatively large areas of tissue may be killed. It has been observed by means of sections that the fungus at times not only kills the tissue around the eye, but also that immediately below it, *Oospora pustulans* has been isolated from a number of eyes killed in this way. As will be obvious from the earlier part of this paper, the details of infection were not ascertained, but there is no evidence at present that infection takes place more readily at the eyes than elsewhere. From these observations it would appear that Milburn's conclusion (p. 91, footnote) that it was the Skin Spot fungus which killed the eyes of several tons of "Evergood" was quite likely to be correct.

Although the primary eyes may be killed, it sometimes happens that secondary eyes may develop. Tubers of "King Edward," most of the eyes of which had been killed by *Oospora*, were placed in boxes to sprout in the usual way, and it was found that of the injured and killed eyes about 45 per cent. developed secondary eyes. Sections through some of these showed that the new buds had pushed their way through the dead tissue. This method of development has been described by Goebel (Einleitung in die Experimentelle Morphologie der Pflanzen. 1908. pp. 221-222). These new buds appeared to be fairly strong and their production affords an explanation of a phenomenon noted when badly spotted tubers were planted at Kew, namely, that all the tubers developed strong plants. On account of the check at the start, however, the plants would be later, and the yield perhaps somewhat less. Though these secondary eyes are undoubtedly developed fairly frequently, many eyes are killed outright, and if it can be avoided it is highly undesirable to plant badly spotted tubers. From the remarks made by Güssow (see p. 492), it is possible that the development of Skin Spot is favoured by bad ventilation during storage, but from observations made in England last year it is clear that Skin Spot is often entirely absent in very badly venti-

lated clamps, and that it sometimes develops in pits where the ventilation is at all events quite up to the average.

The evidence at present available points to the fact that Scotch seed is more affected than English seed, but the question as to whether this is the result of more generally affected soil, the nature of the season, or the methods of storage, must remain over for a future investigation.

Summary.

It is shown in the present paper that the disease of potato tubers known as Skin Spot is caused by a fungus belonging to the Hyphomycetes. The fungus is not *Spicaria solani* Harting as has been previously thought, but a minute species hitherto undescribed, which appears most suitably placed in the genus *Oospora*, and is described as a new species *O. pustulans*, Owen and Wakefield. The fungus grows readily as a saprophyte in culture, including agar and gelatine media, but more freely on sterilised vegetable tissues. The morphological characters of the fungus as seen in artificial cultures are described in detail.

Field inoculations with spores of the fungus were successful in a certain number of cases in producing the spot on the tubers, and the fungus was re-isolated from the affected tubers. Further work on the life history of the fungus is required, as it is not certain whether the tubers are infected in the soil only or also during storage. The exact type of soil and the conditions under which Skin Spot develops with special virulence are not yet clear.

With regard to the injury caused by the disease, the fungus is confined to the surface layers, and is often sharply isolated from the mass of the flesh by a layer of cork cells. Tubers, however, may be so severely spotted as to be greatly disfigured and to be depreciated in value. In addition to this it is shown that previous suppositions with regard to the injury caused by the fungus to the eyes were correct. When infection takes place in the neighbourhood of the eyes these are weakened or killed. In spite of the fact that in some cases secondary eyes are developed, seed tubers may undoubtedly be very seriously injured, when the fungus is present in quantity. The only preventive measure which can be recommended at present is to avoid planting diseased tubers. If badly affected tubers are planted, not only are "misses" likely to occur, but the soil is likely to be seriously affected with Skin Spot fungus.

Incidentally it is shown that the original description and figures of *Spicaria solani* on which Harting first founded the genus are at variance with the commonly accepted idea of the genus as framed by Harz.

In conclusion I should like to record my indebtedness to Mr. A. D. Cotton for his help and criticism during the course of this investigation.

I am also indebted to Mr. F. T. Brooks and Miss A. D. Mackenzie, who commenced a similar investigation at the Food Investigation Department of the Board of Agriculture, but who discontinued the work on learning that it was being carried out at Kew with better facilities.

XXII.—DOLICHANDRONE AND MARKHAMIA.

T. A. Sprague.

The name *Dolichandrone* was given in 1841 by Fenzl* to a group which contained two Australian Bignoniaceous trees, *Spathodea heterophylla*, R. Br., and *S. alternifolia*, R. Br., and which he treated as a section of the South American genus *Dolichandra*, Cham.

Seemann raised *Dolichandrone* to generic rank in 1862,† and quoted *Bignonia spathacea*, Linn. fil. as the type of the genus.‡ He subsequently published a generic description, and an enumeration of the species recognised by him.§ These included five Asiatic ones (*D. Rheedii*, *D. Lawii*, *D. falcata*, *D. crispa*, and *D. serrulata*), and two from Australia (*D. heterophylla* and *D. filiformis*).

The genus *Markhamia* was published in 1863 by Seemann‖ in a single line: "*Markhamia*, Seem. (type, *Spathodea stipulata*, Wall.). Asia trop." Seemann did not indicate how his new genus differed from *Dolichandrone*, nor did he ever supply a description of it.

In 1865 he described¶ the new genus *Muenteria*, which included two African species: *M. stenocarpa*, Seem., a new species collected by Welwitsch in Angola; and *M. tomentosa*, Seem. (*Spathodea tomentosa*, Benth.). He stated that *Muenteria* was allied to *Dolichandrone* and *Markhamia*, but did not mention how it differed from either. Five years later Seemann transferred *Spathodea lutea*, Benth., *S. zanzibarica*, Bojer, and *S. puberula*, Seem., to *Muenteria*.

Bentham reduced *Markhamia* and *Muenteria* to *Dolichandrone*, but recognised them as distinct sections.** K. Schumann restored *Markhamia* to generic rank and treated *Muenteria*, Seem., as a synonym, transferring to *Markhamia* all Seemann's species of *Muenteria*, and describing two additional ones.†† He stated that the capsule of *Dolichandrone* was quadrilocular owing to the presence of a false septum, which was absent in *Markhamia*; but this distinction between the two genera is not borne out by examination of herbarium specimens: an incomplete false septum exists in both genera.

The corolla, however, affords characters which amply justify the treatment of *Markhamia* as a separate genus. In both genera the corolla-tube is more or less funnel-shaped: in *Dolichandrone*, however, the lower and cylindric part of the tube is greatly

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* Darstell. und Erläut. p. 113 (Denkschr. Baier. Bot. Ges. Regensb. vol. iii. p. 265).

† Ann. Mag. Nat. Hist., ser. 3, vol. x. p. 31.

‡ Journ. Bot. 1863, p. 226.

§ l.c. 1870, p. 379.

‖ l.c. 1863, p. 226.

¶ l.c. 1865, p. 329.

** Gen. Plant. vol. ii. p. 1046.

†† Engl. u. Prantl. Nat. Pflanzenfam. vol. iv. 3 B, pp. 229, 242; Engl. Pflanzenw. Ost-Afr. vol. C, p. 363.

developed, and much exceeds the calyx, and the limb is almost actinomorphic; whereas in *Markhamia* the cylindric part of the tube is very short and concealed in the calyx, only the upper part of the funnel being visible, and the limb is conspicuously bilabiate. In addition, *Dolichandrone* has pure white, fragrant flowers which are open during the night, whilst those of *Markhamia* are yellow (rarely pink or lilac), or have a yellowish tube, spotted with purple, and brown-purple lobes, and expand in the daytime. Roxburgh says of *D. crispa*: "the large pure white fragrant flowers . . . expand in the evening and drop in the morning."* Wight states that those of *D. arcuata* usually expand in the evening and drop off in the morning,† and Ridley describes the flower of *D. Rheedii*‡ as "white, with a long tube, and a spreading circle of petals, and very fragrant, scenting the air deliciously in the early morning. The flowers are nocturnal, apparently opening after dark and commencing to fall by seven o'clock in the morning." The nocturnal expansion, white colour and powerful scent of the flowers, and the long, slender corolla-tube all point to the pollination of *Dolichandrone* by moths. No observations as to the pollination appear to have been published, and the genus is not mentioned in Knuth's Handbuch der Blütenbiologie.

It seems desirable to give an enumeration of the species referred to *Dolichandrone* and *Markhamia* respectively, as the synonymy is rather involved, and some of the species are not very well known.

Dolichandrone, *Seem.* in Ann. Mag. Nat. Hist. ser. 3, vol. x. p. 31 (1862); in Journ. Bot. 1863, p. 226; et l.c. 1870, p. 379; Benth. et Hook. f. Gen. Plant. vol. ii. p. 1046, partim (sectionibus *Markhamia* et *Muenteria* exclusis); K. Schum. in Engl. et Prantl, Nat. Pflanzenfam. vol. iv. 3 B, p. 75.—*Spathodea*, R. Br. Prodr. p. 471; Bureau, Monogr. Bignon. p. 50; non Beauv. *Dolichandra*, sect. *Dolichandrone*, Fenzl in Denkschr. Baier. Bot. Ges. Regensburg, vol. iii. p. 265 (1841).

A. *Species australianae.*

1. **D. alternifolia,** *Seem.* in Journ. Bot. 1870, p. 340; Bailey, Class. Index Pl. Queensl. p. 29 (1883); Queensl. Fl. p. 1135. *D. heterophylla*, F. Muell. Fragm. vol. iv. p. 149, partim; Seem. in Journ. Bot. 1870, p. 382, partim. *Spathodea alternifolia*, R. Br. Prodr. p. 472 (1810); DC. Prodr. vol. ix. p. 209; Benth. Fl. Austral. vol. iv. p. 538.

Distrib. Queensland.

F. Mueller and Seemann considered *D. alternifolia* as a mere form of *D. heterophylla*, but Bentham, followed by F. M. Bailey, treated it as a distinct species; and this seems to be the best course to adopt in the present state of our knowledge. The Queensland specimens quoted by Bentham under *D. heterophylla*

* Fl. Ind. vol. iii. p. 104.

† Wight Ic. vol. iv. pt. 2, p. 9.

‡ Journ. As. Soc. Straits, no. 59, p. 40.

(Rockingham Bay, *Dallachy;* between Cleveland Bay and Rockingham Bay, *Hill*) should, however, in the writer's opinion, be referred to *D. alternifolia.*

2. **D. heterophylla,** *F. Muell.* Fragm. vol. iv. p. 149 (1864), in obs., excl. syn.; Seem. in Journ. Bot. 1870, p. 382; Bailey Queensl. Fl. p. 1135; Ewart et Davies. Fl. Northern Terr. p. 250. *Spathodea heterophylla,* R. Br. Prodr. p. 472 (1810); DC. Prodr. vol. ix. p. 207; Benth. Fl. Austral. vol. iv. p. 538.
Distrib. Northern Australia.

3. **D. filiformis,** *F. Muell.* Fragm. vol. iv. p. 149 (1864), in obs.; Seem. in Journ. Bot. 1870, p. 383; Ewart et Davies, Fl. Northern Terr. p. 250. *Bignonia filiformis,* A. Cunn. ex DC. in Ann. Sc. Nat. ser. 2, vol. xi. p. 286 (1839), nomen. *Spathodea filiformis* DC. Prodr. vol. ix. p. 209 (1845); Benth. Fl. Austral. vol. iv. p. 539.
Distrib. Northern Australia.

B. *Species asiaticae.*

4. **D. spathacea,** *K. Schum.* Fl. Kaiser Wilhelms Land, p. 123 (1889); K. Schum et Lauterb. Fl. Deutsch, Sudsee, p. 540; Schimper, Indomal. Standfl. p. 129; Whitford in Philipp. Journ. Sc. vol. i. p. 674; Merrill, Fl. Manila, p. 429; Merrill, Interpr. Rumph. Herb. Amboin. p. 469; Merrill, Spec. Blancoan. p. 349. *D. Rheedii,* Seem. in Journ. Bot. 1870, p. 380; C. B. Clarke in Hook. f. Fl. Brit. Ind. vol. iv. p. 379; Ridl. in Trans. Linn. Soc., Bot., vol. iii. p. 327; et in Journ. As. Soc. Straits, no. 33, p. 120; Trimen Fl. Ceylon, vol. iii. p. 282; Gamble, Man. Ind. Timb. ed. 2, p. 512; King et Gamble, Mat. Fl. Mal. Penins. Gamopet. p. 377; Brandis, Indian Trees, p. 494; Watt, Dict. Econ. Prod. India, vol. iii. p. 174; Koorders in Meded's Lands Plantent. vol. xix. p. 552; Boerl. Handl. Fl. Ned. Ind vol. ii. p. 600; Prain in Rec. Bot. Surv. India, vol. ii. pp. 246, 247, 326; Bourdillon, For. Trees Travancore p. 275; Guillaumin in Ann. Mus. Col. Marseille, 1911, ser. 2, vol. ix. p. 204; Ridl. in Kew Bull. 1910, p. 203; Ridl. in Journ. As Soc. Straits, No. 59, pp. 40, 146 (1911). *D. longissima,* K. Schum. in Engl. et Prantl, Nat. Pflanzenfam. vol. iv. 3 B, p. 240 (1894); Koord. Exkursionsfl. Java, vol. iii. p. 184. *Bignonia spathacea,* Linn. f. Suppl. p. 283 (1781); Retz. Obs. Bot. fasc. v. p. 5; Willd. Sp. Pl. vol. iii. p. 304; Blanco, Fl. Filip. p. 499. *B. longissima,* Lour. Fl. Cochinch. p. 380 (1790). *B. longiflora,* Willd. ex DC. Prodr. vol. ix. p. 206 (1845), in syn. *Spathodea Rheedei,* Spreng. Syst. vol. ii. p. 835 (1825), quoad syn.; Wall. Cat. n. 6516; DC. Prodr. vol. ix. p. 206; Miq. Fl. Ned. Ind. vol. ii. p. 754; Wight, Ic. t. 1339; Beddome, For. Man. p. clxviii.; Kurz, Rep. Veg. Andaman Isl. p. 43; Kurz in Journ. As. Soc. Beng. vol. xlv. p. 142; Kurz, For. Fl. Brit. Burma, vol. ii. p. 234. *S. longiflora,* Vent. Choix, p. 40 (1803); Pers. Syn. vol. ii. p. 173; Decne in Nouv. Ann. Mus. Hist. Nat. Par. 1834, vol. iii. p. 380; Span. in Linnaea, 1841, vol. xv. p. 326. *S. rostrata,* Span. l.c., in syn. *S. grandiflora,* Zipp. ex

Span. l.c., in syn. *S. Loureiriana*, DC. Prodr. vol. ix. p. 209 (1845). *S. luzonica*, Blanco, Fl. Filip. ed. 2, p. 350 (1845); ed. 3, vol. ii. p. 284, t. 242. *S. Diepenhorstii*, Miq. Fl. Ned. Ind. vol. ii. p. 754 (1856-59). *S. macroloba*, Miq. l.c. Suppl. p. 565 (1860). Niir Pongelion, Rheede, Horto. Malab. vol. vi. p. 53, t. 29 (1686). Lignum equinum, Rumph. Herb. Amboin. vol. iii. p. 73, t. 46 (1750).

Distrib. Malabar, Travancore, Ceylon, Sundribuns, Lower Burma, Andaman and Nicobar Islands, Malay Peninsula, Sumatra, Java, Timor, Philippines, Borneo, Celebes, Amboina, New Guinea, Solomon Islands, New Caledonia.

Dolichandrone spathacea seems to be mainly a coastal tree.* According to Beddome, it is common about Tellicherry and elsewhere in the plains of Malabar; it is found on the banks of rivers in Northern Travancore (Bourdillon); in Ceylon it occurs in moist low country, chiefly near the coast, and especially in mangrove swamps (Trimen); it is generally distributed in the Sundribuns, occurring both along the sea-face and in the swamp-forest (Prain). Ridley has recorded it from mangrove swamps and tidal rivers in the Malay Peninsula. It is very common in Java, but is confined to saline ground in the neighbourhood of the coast, and is especially frequent in mangrove swamps (Koorders). According to Merrill, it is widely distributed on the sea-shore and along tidal streams in the Philippine Islands; and it occurs in similar situations in New Guinea (Schumann and Lauterbach). According to Comins, it grows by riversides in San Cristoval, Solomon Islands. The occurence of *D. spathacea* in rice fields near Kanga village, Lower Siam, is explained by Ridley as follows: "The tree is about 60 ft. tall, and is the commonest one in the paddy fields. Doubtless it is one of the relics of the time when the whole of this country was a tidal swamp, gradually filling up after the disappearance of the sea, which overlay all this area. There are several more seashore plants still scattered over the paddy fields, such as the sand-spurge, *Euphorbia Atoto*."

Writing of the origin of the Sundribun flora, Prain mentioned *D. spathacea* as "the only swamp-forest tree for which introduction by wind seems unequivocal," and included it in a list of species which owe their presence at the sea-face of the Sundribuns to some agency other than that of ocean currents. Whilst its local dissemination is no doubt effected to a large extent by wind, the following considerations suggest that dispersal by means of ocean currents may also take place.

The seeds of *D. spathacea* are peculiar in having comparatively short opaque wings of a spongy texture similar to that of the body of the seed, and which has been termed "corky" by Clarke and other authors. The wings of the other species, and of most bignoniaceous seeds, are as long as or longer than the body of the seed, and very thin and hyaline. In these respects the seeds of *D. spathacea* are at the same time worse adapted for transport over long distances by wind, and better adapted for dispersal by

* The records from the interior of Burma are apparently referable to *D. serrulata*.

means of ocean currents. Taking into account also the littoral habitat of *D. spathacea*, and the considerable distances oversea separating various parts of its area of distribution, it seems not unlikely that ocean currents may have played some part in the wide dissemination of the species, although direct evidence of this is up to the present lacking.

5. **D. serrulata**, *Seem.* in Journ. Bot. 1870, p. 383, emend. (specimine ex India centrali excluso); affinis *D. spathaceae*, K. Schum., a qua foliolis minoribus brevius acuminatis, corollae tubi parte superiore longiore, capsulae septo crasso suberoso, seminum alis membranaceis differt.

Arbor 9-15 m. alta (fide *Witt*). Folia 8-22 cm. longa, 2-5-juga; foliola elliptica vel elliptico-oblonga, rarius obovata, 3-8 cm. longa, 1·5-4·5 cm. lata, basi (lateralia inaequaliter) cuneata, in cuspidem 4-6 mm. longam acutam acuminata, integra vel supra medium dentata, supra praesertim versus petiolulum minute lepidota; terminale 5-24 mm. petiolulatum; lateralia 1-10 mm. petiolulata. *Corollae tubus* 11-13 cm. longus; pars superior 5-6 cm. longus. *Capsula* sectione transversa rectangulari, 7-8 dm. longa, 1-1·5 cm. lata, 4-6 mm. crassa; septum crassum, suberosum. *Semina* 2·5-3·5 cm. longa, alis membranaceis.—*Dolichandrone*, n. 7, Brandis, Indian Trees, p. 494 (1906). *D. Rheedii*, Craib in Kew Bull. 1911, p. 433, non Seem. *Bignonia serrulata*, Wall. ex DC. in Bibl. Univ. Genèv. vol. xvii. p. 124 (1838); et in Ann. Sc. Nat., Ser. 2, vol. xi. p. 286 (1839). *B. laeta*, Wall. Cat. n. 6505 (1832); DC. Prodr. vol. ix. p. 171. *Bignonia* foliis pinnatis, floribus maximis, fere spithamaeis infundibuliformibus sub-2-labiatis laciniis crispatis. Griff. Priv. Journ. p. 148 (1847). *Spathodea serrulata*, DC. Prodr. vol. ix p. 206 (1845). *Stereospermum serrulatum*, DC., l.c. in syn.; Kurz, For. Fl. Brit. Burma, vol. ii. p. 230 (1877).

Distrib. Burma: Irrawaddy valley; Shwebo district, *Smales*; Thabet Kyin, *J. W. Oliver* (fide Brandis, l.c.); hills opposite Pagam, *Wallich;* Thayet Myo, *Griffith* (ex Priv. Journ. p. 148); Prome, *Brandis* (fide *Brandis*, l.c.). Lower Siam: Paknampo, common in dry deciduous forest, *Witt.*

When in a flowering state *D. serrulata* bears a strong resemblance to *D. spathacea*, and has been referred to that species. This may perhaps account for the inland distribution in Burma attributed to *D. spathacea* (*Spathodea Rheedii*) by Kurz, who says that it is "not unfrequent in the lower and upper mixed forests from Prome and the Pegu Yomah down to Tenasserim"; but is is possible that the area of the two species overlap. Gage has recorded *D. Rheedii* as one of the more common and conspicuous trees in the fairly open deciduous forest covering the Nwamadaung range, Minbu District, Upper Burma; but it seems possible that the tree in question will prove to be *D. serrulata*. (Rec. Bot. Surv. India, vol. iii. p. 86).

The capsules of *D. serrulata* strongly resemble those of *Stereospermum*, so that, in the absence of flowers, it was formerly assigned to that genus.

6. **D. atrovirens,** *Sprague.—D. crispa,* Seem. in Journ. Bot. 1870, p. 381, excl. syn. nonnull.; C. B. Clarke in Hook. f. Fl. Brit. Ind. vol. iv. p. 379; Gamble, Man. Ind. Timb. ed. 2, p. 512; Brandis, Indian Trees, p. 494, fig. 174; Cooke, Fl. Bombay, vol. ii. p. 329; Talbot, For. Fl. Bombay, vol. ii. p. 308, fig. 436. *Bignonia atrovirens,* Heyne ex Roth, Nov. Sp. pp. 284, 402 (1821); et ex Wall. Cat. n. 6515 C. (1832). *B. crispa,* Ham. in Roxb. Fl. Ind. vol. iii. p. 103 (1832). *B. parviflora,* Hb. Madr. ex. Wall. Cat. n. 6517 B. (1832), in syn. *Spathodea atrovirens,* Spreng. Syst. vol. ii. p. 835 (1825). *S. crispa,* Wall. Cat. n. 6515 (1832); DC. Prodr. vol. ix. p. 206; Dalz. et Gibs. Bombay Fl. p. 160; Brandis, For. Fl. p. 350; Beddome, For. Man. p. clxviii. *S. crispa* var. *petiolulosa,* DC. Prodr. vol. ix. p. 206 (1845).

Distrib. Peninsular India: Belgaum, Dharwar, Mysore, Tinnivelly (Kutallum), Pondicherry. According to Beddome (l.c.), it is not uncommon in subalpine forests throughout the Madras Presidency.

The earliest name for this species is *Bignonia atrovirens,* Heyne, a co-type of which is preserved in the Wallichian Herbarium at Kew, under n. 6515 C. Clarke treated *B. atrovirens* as a synonym of *Dolichandrone falcata* in the Flora of British India, but subsequently identified it with *D. crispa* (MS. in Herb. Wallich). K. Schumann cannot be quoted as the authority for the combination *D. atrovirens* (Heyne), as he used the name for a different species, *D. falcata.* Roth's description of *Bignonia atrovirens* leaves no doubt that the specimen which Heyne sent him belonged to the softly pilose form of *D. crispa,* grown in the Calcutta Botanic Gardens from seeds sent from Mysore by Hamilton (Roxb. Fl. Ind. vol. iii. p. 103), and mentioned by C. B. Clarke (Fl. Brit. Ind. vol. iv. p. 380). This was distributed under Wall. Cat. n. 6515 A. The specimen of *B. atrovirens* sent by Heyne to Wallich belongs, on the other hand, to the glabrous form of the species.

7. **D. arcuata,** *C. B. Clarke* in Hook. f. Fl. Brit. Ind. vol. iv. p. 380 (1884); Gamble, Man. Ind. Timb. ed. 2 p. 513; Brandis, Indian Trees, p. 493. *D. crispa,* Seem. in Journ. Bot. 1870, p. 381, quoad syn. *Spathodea arcuata,* Wight Ic. t. 1340 (1850): Beddome, For. Man. p. clxix.

Distrib. Madras: Ootacamund and Coimbatore; Malabar: Palghat and Valiyar.

D. arcuata differs from *D. atrovirens* in the larger number (up to 11) of leaflets, which are elliptic and shortly or not at all cuspidate, the shorter petiolules, the rather longer calyx, and the larger corolla, with a wider tube and more coarsely undulate lobes. Specimens collected by Wight at Palghat and Valiyar in the Malabar district differ from typical *D. arcuata* in being relatively glabrous, and in the longer petiolules. Clarke referred the Palghat tree to *D. crispa,* but Wight did not distinguish it from *D. arcuata,* and Brandis referred it to the latter.

Beddome's specimen from the Kurnool hills, referred to *D. arcuata* by Clarke and Brandis may possibly belong to this

species, but the material is insufficient to determine it with certainty. It has velvety-pubescent 5-foliolate leaves, and reniform lateral leaflets, with petiolules 7-10 mm. long.

8. **D. falcata,** *Seem.* in Journ. Bot. 1870, p. 381; C. B. Clarke in Hook, f. Fl. Brit. Ind. vol. iv. p. 380, excl. syn. nonnull; Gamble, Man, Ind. Timb. ed. 2, p. 512; Watt, Dict. Econ. Prod. India, vol. iii. p. 174; Brandis, Indian Trees, p. 493, fig. 173; Cooke, Fl. Bombay, vol. ii. p. 329; Talbot, For. Fl. Bombay, vol. ii. p. 310; Haines, Trees Centr. Prov. p. 167. *D. Lawii,* Seem. in Journ. Bot. 1870, p. 380; C. B. Clarke in Hook. f. Fl. Brit. Ind. vol. iv. p. 380; Brandis, Indian Trees, p. 493; Prain, Bengal Pl. vol. ii. p. 789. *D. serrulata,* Seem. l.c. 383, quoad specimen ex India centrali tantum, excl. syn. *D. atrovirens,* K. Schum. in Engl. et Prantl, Nat Pflanzenfam. vol. iv. 3B. p. 240, sed non *Bignonia atrovirens,* Heyne. *D. crispa,* K. Schum. l.c. 240, fig 92A, non Seem. *Spathodea falcata,* Wall. Cat. n. 6517A (1832); DC. Prodr. vol. ix. p. 206, excl. syn. nonnull; Dalz. et Gibs. Bombay Fl. p. 160; Bedd. Fl. Sylv. t. 71; Brandis For. Fl. p. 350. *S. crispa,* Bureau, Monogr. Bignon. Atlas, p. 30, t. 27 (1864), non Wall. *Bignonia spathacea,* Roxb. Cor. Pl. vol. ii. p. 24, t. 144 (1798), non Linn.; Roxb. Fl. Ind. vol. iii. p. 103. *B. falcata,* König ex Roxb. l.c. in syn.

Distrib. India: Rajputana, Bundelkhand, Behar, Central Provinces, Berar, Konkan, Belgaum, Mysore, Madras. According to Beddome, l.c., it is common in most of the forests in the Madras Presidency.

The figure in Roxb. Cor. Pl. t. 144 is poor, especially as regards the shape of the corolla-lobes, but there seems to be no reason for supposing that the capsule belongs to a different species from the flowering branch, as stated by Clarke.

Dolichandrone Lawii appears to be merely a glabrous form of *D. falcata,* as suggested by Brandis. The variation in the indumentum is not correlated with the degree of curvature of the capsule.

C. *Species africana.*

9. **D. alba,** *Sprague.*—*Spathodea alba,* Sim, For. Fl. Port. E. Afr. pp. 92, 116, t. 75 (1909).

Distrib. Portuguese East Africa.

Sim's description and figure leave little doubt that *Spathodea alba* is really a *Dolichandrone.* The spathaceous calyx, the almost actinomorphic white corolla with a long slender cylindric tube and lobes with wavy margins, and the powerful perfume of the flowers all point to this genus, which was previously unknown from Africa. It may be useful to reproduce his description in a slightly modified form, as the work in which it was published is probably not accessible to many botanists.

Spathodea alba.—*Arbor* parva. *Folia* opposita, imparipinnata; foliola 4-juga, subsessilia, ovata, obvata vel elliptica, 5-10 cm. longa, apice rotundata vel obtusa, integra, undulata, glabra. *Racemus* terminalis, usque 4·5 dm. longus, multiflorus. *Flores*

speciosi, albi, suaveolentes, tres tantum simul expansi. *Pedunculus* 5-10 mm. longus. *Calyx* 2-3 cm. longus, unilateraliter fissus. *Corollae tubus* 4-5 cm. longus, cylindricus; limbus rotatus; lobi 2·5 cm. longi, 2 cm. lati, marginibus undulatis. *Pistillum* gracile, 4 cm. longum. *Capsula* linearis, compressa, 3-6 dm. longa, 2-2·5 cm. lata, 2-3 mm. crassa, pubescens, polysperma. *Semina* 1 cm. longa, alis lateralibus inclusis 4 cm. lata.—A small tree, frequent in Lower Gaza, M'Chopes and Inhambane; also present in the forests of Magenja da Costa. So strongly scented that one administrador thought a perfume industry might arise to utilise it.

Vernacular names: Insanye (Gaza and Zuvalla); Dane, Madane or Idane (between Inharreme and Inhambane); Naguro (Quelimane District).

Yields a light grey, very equal timber, of good surface, better than *Trichilia*, less red; weight about 45 lbs.; rings about 12 mm. apart, with many intermediate pores; rays not visible. Valuable board timber, not bored. Bark thin, flaky. Sometimes a large tree.

Markhamia, *Seem.* in Journ. Bot. 1863, p. 226, sine descr.; K. Schum. in Engl. et Prantl, Nat Pflanzenfam. vol. iv. 3B, p. 242 (1895); Sprague in Dyer, Fl. Trop. Afr. vol. iv. pt. 2, p. 522. *Muenteria*, Seem. in Journ. Bot. 1865, p. 329; et l.c. 1870, pp. 211, 338; non Walp. (1846). *Dolichandrone*, sect. *Markhamia* et *Muenteria*, Benth. in Benth. et Hook. f. Gen. Plant. vol. iv. p. 1046 (1876).

The species of *Markhamia* fall into three very natural groups. In the first, which includes *M. stipulata*, *M. cauda-felina*, *M. lutea*, *M. platycalyx* and *M. Hildebrandtii*, the corolla is yellow, and the pseudo-stipules (*i.e.* the first pair of leaves of an axillary shoot, which simulate stipules) are foliaceous and orbicular.

The second group includes *M. sessilis*, *M. tomentosa* and *M. obtusifolia*, and is characterized by a yellow corolla and subulate pseudo-stipules. The third group contains *M. puberula*, *M. stenocarpa*, *M. zanzibarica* and *M. acuminata*. It differs from both the preceding groups in the brownish purple corolla-lobes and purple spotted tube; and has foliaceous, orbicular pseudo-stipules.

The nearest affinities of *Markhamia* are with *Heterophragma*, DC., which differs in its non-spathaceous, irregularly lobed calyx.

A. *Corolla lutea; pseudostipulae orbiculares.*

1. **M. stipulata,** *Seem.* in Journ. Bot. 1870, p. 341; K. Schum. in Engl. et Prantl, Nat. Pflanzenfam. vol. iv. 3B, p. 242. *Bignonia stipulata*, Roxb. Hort. Beng. p. 47 (1814), nomen; Roxb. Fl. Ind. vol. iii. p. 108 (1832). *B. campanulata*, Ham. ex Wall. Cat. n. 6518A. *Spathodea stipulata*, Wall. Cat. n. 6518A; n. 6518D; n. 6518C, quoad specim. e Segaen; Wall. Pl. As. Rar. vol. iii. p. 20, t. 238 (1832); DC. Prodr. vol. ix p. 205; Kurz, Rep. Veg. Andaman Isl. p. 43; Kurz, For. Fl. vol. ii. p. 234. *S. campanulata*, Ham. ex Wall. Pl. As. Rar. vol. iii.

p. 20 (1832), non Beauv. *S. velutina*, Kurz in Journ. As Soc. Beng. vol. xlii. p. 90 (1873); Kurz, For. Fl. vol. ii. p. 235 (1877). *Dolichandrone stipulata*, Benth. ex C. B. Clarke in Hook. f. Fl. Brit. Ind. vol. iv. p. 379 (1884); Brandis, Indian Trees, p. 493; Gamble, Man. Ind. Timb. ed 2, p. 512; Watt, Dict. Econ. Prod. India, vol. iii. p. 174; Gage in Rec. Bot. Surv. India, vol. iii. p. 86.

Distrib. Upper and Lower Burma; Andaman Islands.

Corolla foetid but eaten (Brandis); limb yellow, tube dirty reddish outside.

According to Gage, l.c., *M. stipulata* is amongst the more common and conspicuous trees in the fairly open deciduous forest covering the Nwamadaung range, in the Minbu district of Upper Burma. Kurz states that it is "rather rare in the open and the drier upper mixed forests of the Pegu Yomah and Martaban, as far down as Rangoon; also Ava." The type of *Spathodea velutina*, Kurz, is not at Kew, but, judging from the description, it seems hardly separable from *M. stipulata*, even as a variety.

M. stipulata, var. **Kerrii,** *Sprague;* capsules densissime lanatis differt.—*M. stipulata*, Craib. in Kew Bull. 1911, p. 433.

Distrib. Siam: Lakon district; near Hang Sut, in deciduous jungle, 360 m., *Kerr* 1013.

A well-marked variety, or possibly a distinct species. As noted by Craib, the indumentum of the capsule resembles that of *M. cauda-felina*, but the capsule is broader, the seeds are larger and the flowers smaller than in that species.

The following specimens may be assigned provisionally to *M. stipulata* var. *Kerrii*, though the material does not admit of a complete comparison:

Yunnan: Red River valley, south of Mengtze, 900 m., *Henry* 10121; Szemao, on mountains, 1200 m., *Henry* 10121 A. Kwangsi: Lungchow, on plain, *Morse* 291. Tonkin: woods near Phuong Lam, *Balansa* 3796.

2. **M. cauda-felina,** *Craib* in Kew Bull. 1911, p. 433, in obs. *Spathodea cauda-felina*, Hance in Journ. Bot. 1872, p. 257; et l.c. 1874, p. 177. *Dolichandrone cauda-felina*, Benth. ex Hemsl. in Journ. Linn. Soc. Bot. vol. xxvi. p. 235 (1890).

Distrib. China: Hainan.

The flowers are the largest in the genus: corolla 12-14 cm. in diameter, limb sulphur-yellow, tube dirty yellowish red outside. According to Hance, the fresh flowers have a disagreeable smell, much like that of raw shrimps.

A specimen collected at Montufar, Albay, Luzon, Philippine Islands, by Vidal (No. 3398), has leaves rather resembling those of *M. cauda-felina*, but the flowers (which are unfortunately in the bud stage) seem rather smaller, and the indumentum of the calyx is finer than in that species. Vidal's specimen is mentioned as *Dolichandrone* sp. in Cat. Pl. Herb. Fl. For. Filip. p. 127 (1892).

3. **M. lutea,** *K. Schum.* in Engl. et Prantl, Nat. Pflanzenfam. vol. iv. 3B, p. 242, quoad syn., excl. loc.; De Willd. et Durand, Reliq. Dewevr. p. 172; Sprague in Hook. Ic. Pl. sub. t. 2800; Sprague in Dyer, Fl. Trop. Afr. vol. iv. pt. 2, p. 525. *Spathodea lutea*, Benth. in Hook. Niger Fl. p. 461, quoad specim. e Fernando Po. *Muenteria lutea*, Seem. in Journ. Bot. 1870, pp. 211, 338, excl. specim. a Barter lect. *Dolichandrone lutea*, Benth. ex Hook. f. et Jacks. Ind. Kew. vol. i. p. 785 (1893).

Distrib. West Africa: Gold Coast, Cameroons, Fernando Po, Belgian Congo (fide De Wild. et Durand).

Corolla yellow (*Mann, Vogel*). A form with lilac corolla has been collected in the Gold Coast Colony by Mr. T. W. Brown.

4. **M. platycalyx,** *Sprague* in Hook. Ic. Pl. t. 2800 (1905); et in Dyer, Fl. Trop. Afr. vol. iv. pt. 2, p. 525. *Dolichandrone platycalyx*, Baker in Kew Bull. 1894, p. 30.

Distrib. Uganda; British East Africa.

An important timber tree, common and widely distributed in Uganda and British East Africa, where it is known respectively under the vernacular names "Lusambia" and "Lusiola." According to Mahon (Herb. Kew.), it yields the finest of local timbers in the Entebbe district; and Moon (Herb. Kew.) states that in Kavirondo it forms a very fine timber tree, up to 70 ft. high; and that the wood takes a beautiful polish and is used by the natives for making stools and for hut slabs.

The corolla is of a rich yellow colour, with the lower lobes striped on the inside with red. (*Wilson.*)

5. **M. Hildebrandtii,** *Sprague* in Hook. Ic. Pl. t. 2800, fig. 9 (1905); et in Dyer, Fl. Trop. Afr. vol. iv. pt. 2, p. 526. *Dolichandrone Hildebrandtii*, Baker in Kew Bull. 1894, p. 31.

Distrib. British East Africa; Usambara.

Corolla yellow (*Hildebrandt*).

B. *Corolla lutea; pseudostipulae subulatae.*

6. **M. sessilis,** *Sprague* in Dyer, Fl. Trop. Afr. vol. iv. pt. 2, p. 526 (1906). *Muenteria tomentosa*, Seem. in Journ. Bot. 1865, p. 330, t. 35, quoad icon. et specim. angolens., excl. syn.; Seem. l.c. 1870, pp. 211, 338, quoad specim. angolens., excl. syn. *Markhamia tomentosa*, Hiern, Cat. Afr. Pl. Welw. vol. i. p. 772 (1900), non K. Schum.

Distrib. West Africa: Lower Congo; Angola.

Corolla yellow, with narrow reddish-purple stripes. (*Welwitsch.*)

M. sessilis, var. **brachyrhyncha,** *Sprague* in Dyer, Fl. Trop. Afr. vol. iv. pt. 2, p. 527 (1906).

Distrib. French Congo.

7. **M. tomentosa,** *K. Schum.* ex Engl. Glied. Veg. Usambara, p. 34 (1894), quoad syn. tantum; K. Schum. in Engl. et Prantl, Nat. Pflanzenfam. vol. iv. 3B, p. 242, partim; Sprague in Dyer, Fl. Trop. Afr. vol. iv. pt. 2, p. 528; Wernham in Cat. Talbot's

Niger. Pl. p. 139. *Spathodea tomentosa*, Benth. in Hook. Niger Fl. p. 462 (1849). *S. lutea*, Benth. l.c. 461, quoad specim. nigericum. *Muenteria tomentosa*, Seem. in Journ. Bot. 1865, p. 330, quoad syn., excl. descr. icon. et specim. angolens.; *M. lutea*, Seem. l.c. 1870, pp. 211, 338, quoad Barter 555. *Dolichandrone tomentosa*, Benth. ex Hook. f. et Jacks. Ind. Kew. vol. i. p. 785 (1893).

Distrib. West Africa: from Senegambia to the Cameroons.

Corolla usually yellow. A form with a rose-coloured corolla has been collected in Spanish Guinea by Tessman.

M. tomentosa, var. **gracilis,** *Sprague* in Dyer Fl. Trob. Afr. vol. iv. pt. 2, p. 528 (1906). *Muenteria lutea*, Seem. in Journ. Bot. 1870, pp. 211, 338, quoad Barter 1310.

Distrib. Northern Nigeria: Nupe, *Barter* 1310.

A very distinct-looking variety, differing from the type in the smaller, very shortly cuspidate calyx. The corolla is golden, with reddish stripes (*Barter*).

8. **M. obtusifolia,** *Sprague.*—*M. lanata*, K. Schum. in Engl. et Prantl, Nat. Pflanzenfam. vol. iv. 3B, p. 242 (1895); Sprague in Hook. Ic. Pl. t. 2800, fig. 8; et in Dyer, Fl. Trop. Afr. vol. iv. pt. 2, p. 527; S. Moore et Swynnerton in Journ. Linn. Soc., Bot., vol. xl. p. 155. *M. tomentosa*, K. Schum. in Engl. Glied. Veg. Usambara, pp. 34, 49 (1894), quoad descr. et loc., excl. syn.; et in Engl. Jahrb. vol. xxviii. p. 480. *M. paucifoliolata*, De Wild. Etudes Fl. Katanga, p. 131 (1903). *M. Verdickii*, De Wild. l.c. 132 (1903). *Dolichandrone obtusifolia*, Baker in Kew Bull. 1894, p. 31.

Distrib. Belgian Congo, British Central Africa, Rhodesia, and East Africa, from Usambara to the Zambesi.

The earliest name for the species is *Dolichandrone obtusifolia*, Baker (1894). In Nyasaland and Gazaland it is a tree 6-9 m. high, (*Purves*, *Swynnerton*), on the lower Shire river and lower Zambesi river, a shrub 1·5-4·5 m. high (*Kirk*), and near the Victoria Falls, a bushy tree 1·8-2·4 m. high, growing on granite sand (*Sykes*). According to Swynnerton, l.c., it is known by the vernacular (Chindao) name "Mubfeya" in Gazaland, where the wood is a favourite with native bowyers, the bark is employed as a substitute for rope, and a decoction of the roots is said to be used for fever and colic.

The corolla is yellow, striped with chocolate. (*Purves*).

C. *Corollae lobi brunneo-purpurei; pseudostipulae orbiculares.*

9. **M. puberula,** *K. Schum.* in Engl. et Prantl, Nat. Pflanzenfam. vol. iv 3B, p. 242 (1895); in Engl. Jahrb. vol. xxviii. p. 480; et in Engl. Pfl. Ost-Afr. vol. C, p. 363; Sprague in Dyer, Fl. Trop. Afr. vol. iv. pt. 2, p. 523. *Spathodea puberula*, Klotzsch in Peters, Reise, Mossamb. Bot. p. 192 (1861). *Muenteria puberula*, Seem. in Journ. Bot. 1870, pp. 212, 339. *Dolichandrone hirsuta*, Baker in Kew Bull. 1894, p. 31.

Distrib. East Africa, from Uluguru to the Lower Zambesi.

Corolla-lobes brownish purple; tube purple-spotted.

10. **M. stenocarpa,** *K. Schum.* in Engl. et Prantl, Nat. Pflanzenfam. vol. iv. 3B, p. 242 (1895); Hiern, Cat. Welw. Afr. Pl. vol. i. p. 791; Sprague in Dyer, Fl. Trop. Afr. vol. iv. pt. 2, p. 523. *Muenteria stenocarpa,* Seem. in Journ. Bot. 1865, p. 329, t. 36, excl. specim. a Kirk lect. *Spathodea stenocarpa,* Welw. ex Seem. l.c. *Dolichandrone stenocarpa,* Baker in Kew Bull. 1894, p. 31.

Distrib. Angola.

Corolla greenish sulphur in colour outside, deep sulphur inside, marked with longitudinal dark purple lines and spots; lobes dusky purple inside (*Welwitsch* 483); corolla white or yellow, variegated with a rose or violet colour (*Welwitsch* 482).

11. **M. zanzibarica,** *K. Schum.* ex Engl. Glied. Veg. Usambara, pp. 34, 36 (1894); et in Engl. et Prantl, Nat. Pflanzenfam. vol. iv. 3B, p. 242; Sprague in Dyer, Fl. Trop. Afr. vol. iv. pt. 2, p. 523. *M. sansibarica,* K. Schum. ex Engl. Glied. Veg. Usambara, p. 16 (1894); in Engl. Pfl. Ost-Afr. vol. C, p. 363; et in Engl. Jahrb. vol. xxxiii. p. 332. *Spathodea tenuifolia,* Bojer, Hort. Maurit. p. 219 (1837), nomen. *S. zanzibarica,* Bojer ex DC. Prodr. vol. ix. p. 208 (1845); Klotzsch in Peters, Reise Mossamb. Bot. p. 191. *Muenteria zanzibarica,* Seem. in Journ. Bot. 1870, p. 339. *Dolichandrone latifolia,* Baker in Kew Bull. 1894, p. 31.

Distrib. East Africa, from Mombasa to Mozambique.

There is an excellent coloured drawing of *M. zanzibarica* in the Kew collection. It was received without a name from L. Bouton in 1863; on the other side of the same cardboard was an uncoloured drawing of *Phyllarthron Bojerianum,* DC., endorsed "Phyllarthron Bojerianum, DC. Prod. Hab. in Ins. Madagascar. Cult. in Ins. Maur." These two drawings were probably executed by Bojer from the living shrub and tree, cultivated at Pamplemousse, and included in his Hortus Mauritianus pp. 219, 221 (1837) under the names *Spathodea tenuifolia,* Boj., and *Arthrophyllum madagascariense,* Boj., respectively. Bojer appears to have sent specimens of *Markhamia zanzibarica* to De Candolle on two occasions: in 1831 under the name *Spathodea zanbibarica,* and in 1839 as *Spathodea tenuifolia.* De Candolle adopted the former name in the ninth volume of the Prodromus, and the effective publication of the species dates from that work, since no description was given of *S. tenuifolia* in the Hortus Mauritianus.

In Zanzibar *M. zanzibaricus* occurs as a shrub 3 m. high on the slopes of coral-limestone hills (*Hildebrandt*); in the coast region of British East Africa it is a small tree, rarely exceeding 9 m. in height (*Battiscombe*). The corolla-tube is buff-coloured with brownish purple spots, and the lobes are brownish purple.

12. **M. acuminata,** *K. Schum.* in Engl. Pfl. Ost-Afr. vol. C. p. 363 (1895); Sprague in Dyer, Fl. Trop. Afr. vol. iv. pt. 2, p. 524; N. E. Brown in Kew Bull. 1909, p. 126; Swynnerton et S. Moore in Journ. Linn. Soc., Bot. vol. xl. p. 155. *M. infundibuliformis,* K. Schum. in Engl. et Prantl, Nat. Pflanzenfam. vol. iv. 3B, p. 242 (1895); et in Engl. Pfl. Ost-Afr. vol. C, p. 363.

Spathodea acuminata, Klotzsch in Peters, Reise Mossamb. Bot. p. 191 (1861). *Muenteria stenocarpa*, Seem. in Journ. Bot. 1865, p. 329, quoad specim. a Kirk lect.

Distrib. East Africa, from Msalala to the Lower Zambesi, Rhodesia, Ngamiland and Transvaal (Zoutpansberg District).

M. acuminata is described as a shrub (*Peters*, *Foye*), or a small tree (*Johnson*, *Swynnerton*). In Ngamiland, according to Lugard, it is a tree 3-3·5 m. high, and "never seems to attain a girth beyond a few inches." On an island near the Victoria Falls, it attains a height of 6-7·5 m., according to Allen.

In Gazaland it is known by the vernacular (Chindao) name "Musiramyati," and yields a durable timber used for rafters, etc. (*Swynnerton*). The known distribution of *M. acuminata* has been extended southwards by its discovery in the Zoutpansberg District of the Transvaal by Mr. J. Foye, who has communicated the following note on its occurrence, through the Division of Botany, Department of Agriculture, Pretoria:

"The situation where this shrub grows is at the base, and on the granite koppies that encircle Messina mine to the south-east like an amphitheatre, a quarter of a mile or so away from the koppies; the shrub is but rarely met with beyond this distance: on the deeper red soil of the flats I have not yet seen a single specimen; it also grows on or about the koppie to the north of the mine of the Messina Company named 'Vogellanzang.' There may of course be many other places, but the above are all that are known to me. One thing I feel pretty sure about, that away from rocky situations it will not be found."

The corolla-lobes are brownish-purple or maroon, and the tube is yellow or buff-coloured with brownish purple spots. The capsule is sometimes 9 dm. long (*Johnson*). A copy of a water-colour drawing by Mrs. E. J. Lugard is contained in the Kew collection.

XXIII.—MISCELLANEOUS NOTES.

George Stephen West.—We have to record, with great regret, the death of Professor G. S. West, D.Sc., M.A., A.R.C.S., F.L.S., which took place on August 7th last, after only a short illness, but he had been in indifferent health for some considerable time. He was Mason Professor of Botany at the University of Birmingham, a post which he had filled with great distinction for ten years, having previously been lecturer under his predecessor, Professor W. Hillhouse. His chief pursuit was the study of Freshwater Algae from all parts of the world, especially of the Diatoms and Desmids, in the latter of which he made for himself an unequalled name: he knew at first sight nearly every British Desmid, and a large proportion of the exotic ones.

He was an excellent lecturer and teacher, much admired and respected by his pupils; he managed his department with great success, and had gathered round him a band of students who

were inspired by his example, especially the post-graduate students who investigated such subjects as the Algae of the soil, and the forms of the chloroplasts of Desmids, in both of which they made unexpected discoveries. His chief works, besides numerous contributions to periodicals on Algae from every country, were the four volumes on British Desmids, published by the Ray Society, a treatise on the British Freshwater Algae, published in 1904, and the first volume of the Cambridge Botanical Handbooks, which treats of the Chlorophyceae and allied forms (1916). He had intended to follow up the latter by a work in which all the British species of Freshwater Algae (excluding the Diatoms and Desmids) should be adequately described and illustrated; part of this is already done, and those who knew Professor West's accuracy and zeal were looking forward to a volume which should rescue this branch of the science from the low level to which it had sunk through previous attempts. His premature decease at the early age of 43 is a loss to Algology which will not easily be repaired, and it is to be hoped that that portion of his work which is completed, but unpublished, will not be allowed to perish. W. B. G.

Retirement of Museum Preparer.—In May of the present year, Mr. George Badderly, for 39 years preparer in the Museums, retired when within a few days of the completion of his 81st year. His early life was spent at Berkhamsted, where he served his apprenticeship as a carpenter. On leaving Berkhamsted he spent several years at carpentry and cabinet work with leading London firms, and was then appointed a preparer at the India Museum. When the India Museum collections were transferred to Kew Badderly came with them, commencing his new duties on April 1st, 1880. On the completion of the North Gallery, he assisted Miss North in the arrangement and mounting of the pictures, afterwards occupying the adjoining residence with his wife, who acted as the official caretaker until within a few months of her death in 1915. Throughout the whole of this time they were held in high esteem by officials and visitors. After his wife's death Badderly wished to retire, but owing to the war the difficulty of filling his place was so great that he consented to carry on his duties until the present year. An example of the best type of British workman, clever, careful and painstaking, Badderley has always been a perfect master of his craft. His readiness to undertake difficult tasks and to impart his knowledge to others, together with his cheerful disposition, gained him the affection of everyone, and his retirement is a distinct loss to the establishment in which he served so long.

New Zealand Flax.—In the Annual Report of the New Zealand Department of Agriculture for 1908, pp. 405-412, an account is given of experiments conducted in the cultivation of the different varieties of New Zealand Flax or Hemp (*Phormium tenax*) with a view to ascertaining their respective

fibre values, and a summary of that report is given here as a continuation of the article on New Zealand Flax which appeared in *K.B.*, No. 4, 1919.

The varieties tested were as follows:—

Awanga.—An erect variety producing a strong heavy leaf with a thick, pulpy, white butt. The fibre is strong, coarse, and bright, easily stripped, washed and bleached. The colour of the finished fibre shows a marked difference to that of other varieties, except *Huhiroa.* The variety produces a heavy crop of leaves per acre, but the fibre yield per ton of green leaves is low. *Ngutunui.*—A variety highly prized by the natives and used by them for making the finer kinds of mats (shawls), the fibre being very strong and elastic. It is a drooping variety with a shorter leaf than some of the others. The leaf is thin with a red butt and is rather difficult to wash and bleach on account of the colour. The fibre is thin but strong and tough, and closely resembles the better qualities of Manila hemp. In point of strength it is by far the best of any tested. *Putaiore.*—This is an erect variety growing 8-10 ft. high, with an even leaf throughout, the butt or base being little thicker than the top. It gives a good return of fibre per ton of green leaf, multiplies quickly and throws up numerous shoots. *Whararíki.*—Of drooping habit, with a thin paper-like leaf, seldom more than 5 ft. long. The yield per acre of green leaf is very small. It produces a very fine, silky fibre, but is too easily bruised and broken in stripping. The fibre was graded the lowest on the list, owing to its bruised condition and lack of strength. The variety is generally known to the miller as "hill" or "mountain" hemp. With an improved method of stripping which would not break or injure the fibre it is considered that the fine silky nature of the fibre of this variety would make it equal, if not superior to other varieties tested for fine and high-class work. *Nguturua* or *Ngutuwahine.*—Grows with and closely resembles *Ngutunui.* The chief difference is seen on cutting the leaf, the butt of *Nguturua* being white and that of *Ngutunui* very red. The fibre of the former, although strong and fairly easily worked, does not compare with that of *Ngutunui* as far as strength is concerned. The fibre, being fine, is used by the natives for the finer kinds of shawls. *Katiraukawa.*—This is a slightly drooping variety, often 12 ft. high, resembling *Awanga,* except that the latter is an erect variety and is stronger and heavier at the butt, having more vegetation. The fibre resembles that of *Awanga,* but is finer and softer. The natives use it for the softer parts of the best mats, and in all kinds of work where fibre is used. *Huhiroa.*—Has strong, erect, dark green leaves, very pale on the under surface. It resembles the *Putaiore* in appearance, the leaf being narrow and of fairly even thickness throughout, but yielding less fibre. The fibre is highly prized by the natives and when stripped by their method it is very strong and bright, and is used in all their finer kinds of work. *Oue* (semi-bronze).—This has a very broad, thick leaf, not so pointed as the other varieties cultivated. The butt is very heavy and coarse, the fibre fine and silky, of medium colour, but defective

in strength. The variety is not recommended for commercial purposes. *Paretaniwha.*—A tall, erect variety 10 ft. high with a thick butt, bearing a good proportion of good, strong, coarse, free fibre. *Harakeke Parae.*—This is a strong-growing variety, most of the butts red, the leaf hard and somewhat difficult to strip and treat generally. It yields a fair percentage of fibre, but faulty in colour, harsh to the touch, and poor in strength.

The following table shows the quantity of green leaf required by each variety to produce one ton of fibre:—

	Tons.	cwt.	qr.	lb.
Awanga	10	11	1	8
Ngutunui	8	7	3	17
Putaiore	8	2	1	24
Harakeke Parae	8	11	0	11
Whaririki	8	4	2	23
Nguturua	8	15	2	20
Uncultivated	8	4	0	11
Katiraukawa	9	9	3	9
Oue	10	7	1	17
Huhiroa	8	12	1	6
Paretaniwha	8	19	0	22

In several cases the leaves were badly injured by fungi and caterpillars and the yield of fibre was reduced thereby.

In the Journal of the New Zealand Department of Agriculture, iii., July 15th, 1911, pp. 60-61, an account is given of a new variety raised by Mr. A. W. Green, of the Ruakara Experimental Farm, by crossing the varieties Awanga and Putaiore, which is said to possess great disease resisting properties and at the same time to yield a high percentage of medium quality fibre.

In 1872 descriptions of a large number of varieties were given in a pamphlet by Sir James Hector, entitled "Phormium tenax as a Fibrous Plant," pp. 1-134, prepared for the Colonial Museum and Survey Department: Second edition, pp. 1-95 (1889). Some of the varieties mentioned above are included in the older work, but several of them are not there recorded.

Variation in Hevea brasiliensis.—A paper of considerable importance and interest to those engaged in the Para rubber industry has been published in the "Annals of Botany," Vol. XXXIII., No. CXXXI., July 1919, p. 313, by Mr. Stafford Whitby, M.Sc., A.R.C.S., of McGill University, Montreal, Canada.

The paper embodies the results of the observations made by the author in the Federated Malay States as to the extent to which variation occurs in the amount of rubber yielded by individual trees of *Hevea brasiliensis* of the same age and growing under the same conditions. He also investigated the possible correlation between the yield of rubber and the girth of the trunk. Some 1000 trees, seven years old, in a normal plantation covering about 13 acres, were carefully studied, the trees being in their third year of tapping. As the Eastern plantations have been made with trees raised from non-selected seed, the results of the investigation are of particular interest. Great variations were found in the rubber content of the latex (the

"strength" of the latex) from different trees, and appeared to be constant and characteristic for the individual tree. Some trees yielded only 23 grms. of rubber per 100 c.c. of latex, while at the other extreme trees were found yielding as much as 54-55 grms. of rubber per 100 c.c. of latex, the mean for the 245 trees examined in this connection being 36·58 grms. per 100 c.c.

The author concludes from his observations on older trees, that as a tree grows older the rubber content of the latex yielded by it increases 1-2 per cent. per annum. The results are set out in tabular form, and while only relatively few trees show the lower percentages of from 23-29 grms. and the higher from 44-55 grms, the majority yield amounts varying from 30-43 grms.

With regard to yield of rubber, it was found that individual trees were comparatively constant and from observations extending over two years it is stated that a tree which was found to be a high yielder at one time could be relied upon to give a high yield at all times. The yield-results are summarised in a table and by means of a curve, and embody the examination of 1011 seven-year old trees.

The mean yield in grammes per day came to 7·12 grms., but some few trees yielded more than 27 grms. a day, and for a large number the yield was from 0-2 grms. Thus from 9·6 per cent. of the total number of trees 28 per cent. of the total yield was contributed, while 13·7 per cent. (0-2 grms. group) only gave 2·9 per cent. of the yield and certainly did not repay the cost of tapping. Four outstanding trees in the plantation gave 41·45, 41·56, 41·72 and 42·77 grms. per day.

The great possibilities of seed selection in improving rubber yield are very clearly indicated from these figures.

A further important observation in connection with seed selection to which Mr. Whitby draws attention is that the seeds from any one tree are exactly similar in appearance as regards tint, mottle pattern and shape.

It now remains to be seen whether seeds from a high-yielding tree will give rise to trees similar to the parent. This is hardly likely to be the case under present plantation conditions, where high and low-yielding trees are indiscriminately intermixed. But it does seem to be indicated that if high-yielding trees can be segregated, and provided that pollen of poor-yielding trees be prevented access to the flowers, seeds capable of producing trees yielding a high percentage of rubber would be assured.

The author also gives particulars of the correlation between yield and girth, which indicate that though there is a definite correlation—trees with a large trunk being good yielders and those with small trunks being poor yielders—it is not sufficiently well indicated to be of great value in eliminating trees from a plantation.

It is of interest to notice that A. A. L. Rutgers ("Selectie en Uitdunning," Archief voor de Rubber culturer, 1919, 3, pp. 105-123) has made observations in Sumatra in full accord with those of Mr. Whitby and finds that "good trees remain good, poor trees remain poor." A. W. H.

Austrian Botanical Expedition to Southwest China.—The last of the preliminary reports of the Austrian Expedition to Southwest China, conducted by Camillo Schneider and Dr. H. Handel-Mazzetti, having come to hand, we are now able to give a short account of this enterprise which promises to add much to our knowledge of an area which has already yielded so many botanical treasures, thanks to the enthusiasm of the French Missionary Delavay and the untiring energy of George Forrest. The expedition was undertaken on behalf of the Dendrological Society, with the support of the Academy of Sciences of Vienna. It started from Yunnanfu in March, 1914, and had the mountain ranges of the Upper Yangtsekiang basin between 27° and 30° N. Lat. as its principal object, a plan which, however, was subsequently considerably modified. The ground covered by the work of 1914 may be briefly indicated by the following localities which can be traced in any large Atlas—Hweili-chou, Ningyanfu, Yenyuanhsien, Kwapi (28° N. Lat.; all these in the Yalung basin in Southern Szechuan), Yungning, Siachungtien, Likiang North East Yunnan). In July Schneider left for Talifu and eventually went to America, whilst Handel-Mazzetti continued the work for the next five years. He visited the southern corner of Szechuan a second time in the autumn of 1914. The early spring of 1915 saw him at Mengtze, Henry's collecting ground, and at Manhao on the Red River (South Yunnan). Then having returned to Yunnanfu he went over the Yunnan plateau to Likiang, Tschungtien, Weih-si, and crossed the Mekong near Tseku for the Doker-La to take up and supplement Forrest's work in that region. He finally penetrated as far as the watershed between the Salween and the Kiu-kiang, the easternmost feeder of the Irawaddi. Having spent the winter 1915-16 at Yunnanfu he went once more viâ Likiang to the Chinese portion of the upper Salween basin which he explored up to its western and northern boundaries. After another winter at Yunnanfu Handel-Mazzetti decided on a traverse of Kweichow and Hunan through botanically unexplored country. His route lay over Kweiyang, Tuyunfu, Kuchow and Lipingfu (Southeastern Kweichow), then Tsingchow, Wukangchow, Sinning, Yungchow, Hangchow to Changsha (all these in Hunan), where he spent the winter 1917-18. The following summer was devoted to the exploration of Central Southwest Hunan. The final preparation of his extensive collections occupied the winter 1918-19, and the early spring of the present year, Handel-Mazzetti leaving Changsha on the 25th March.

Handel-Mazzetti has travelled before in Kurdistan and Northern Mesopotamia, and won a reputation as botanical explorer and geographer. As he is moreover an experienced mountaineer and an excellent photographer, we may look forward to a rich harvest in botany and geography. A preliminary account of the floral zones and plant-formations of Yunnan and Southwest Szechuan was published in the Akademischer Anzeiger of the Vienna Academy for 6th July, 1916 (No. 18), and 22nd November, 1917 (No. 24), whilst a preliminary report on the vegetation of Kweichou and Hunan is in the press. The first deals with (A) the tropical region, studied by him in the

neighbourhood of Manhao on the Red River, (B) the Yunnan plateau (subtropical up to 6000 ft. and warm temperate: 6000-9500 ft.), (C) the High Mountains of Southwest Szechuan and North Yunnan (subtropical: 5000-8000, or locally 9000 ft.; warm-temperate: 8000 or locally 6200 to 8200, or in very dry situations 9500 ft.; temperate: 8200-12,500 ft.; cold-temperate: 12,000-14,600 ft.; high-alpine: 14,600-16,400 ft.), (D) the High Mountains of the Northeast Burma—West Yunnan frontier (warm-temperate: 6000-9000 or locally 10,800 ft.; temperate: 8200-11,500 ft.; cold-temperate: 11,500-13,800 on western slopes or 14,400 on eastern slopes; high-alpine: from 13,800-14,400 upwards). Among the most remarkable discoveries may be mentioned the Conifer *Taiwania cryptomeroides* (so far only known from Formosa) as far west as the Salween, a Cedar on the Mekong, *Juglans regia* wild on the Salween, a practically black-flowered *Rhododendron*, and a saprophytic chlorophyll-less orchid 8 ft. high. O. S.

Presentation of Early Water-Colour Drawings.—Prof. F. W. Oliver, F.R.S., has presented five interesting and very beautiful early water-colour drawings of flowers for exhibition with Sir Arthur Church's collection of drawings in the North Gallery (see *K.B.*, 1916, p. 162). These drawings come from the collection made by his father, the late Prof. Daniel Oliver, F.R.S., for many years keeper of the Herbarium.

Two are early works probably of the Dutch school, but the artist or artists are not known; they formed part of the Sunderland collection which was sold in 1883.

1. Is an unfinished study of Tulips and Double Anemones.
2. A study of three Anemones.

   The quality and tone of the paper adds greatly to the charm of these two fine drawings.
3. A group of Polyanthus and Primroses by Maria Sibylla Merian.*

   This and the following picture were in Lord Bute's collection and then in the Beale collection before they were acquired by Prof. D. Oliver.
4. A crimson *Senecio*, by Nicholas Juweel.†
5. *Fritillaria imperialis* with bulb, by an unknown artist, also from the Sunderland collection.

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* Merian, Maria Sibylla.—Daughter of Matthew Merian, the engraver, was born at Frankfort-on-Maine in 1647 and died at Amsterdam in 1717. She painted flowers and insects usually in water colour on vellum. Her work on European insects and the plants on which they feed went through several editions. Her most famous book was the folio illustration of the metamorphosis of Surinam insects with the trees on which they feed, and many of the plates she also engraved. She was in Surinam from 1699 to 1701. Her father's book, "Florilegium Renovatum et auctum," is well known. Two volumes of her drawings are preserved at the British Museum. Her husband, Johann Andreas Graffen, was also an artist.

† Juweel, Nicholas.—A painter of Rotterdam living in 1690 who imitated the manner of Chevalier van der Weiff.